Pressure Drop Basics & Valve Sizing

Combination T/P Shower Valves
Lavatory Tempering Valves
Master Tempering Valves
Hi/Lo Tempering Systems
Emergency Tempering Valves
Surface Mounted Shower Systems
Pressure Balancing Valves
ASSE/CSA Listed

POWERS
Water Tempering Innovation Since 1891
What is Pressure Drop?

- The difference in pressure between two points in a system, caused by resistance to flow.
What Pressure Drop is Not?

- Pressure drop is pressure loss across the valve created by system demand - NOT by the valve alone.
What is Pressure Drop?

- Pressure Drop = $\Delta P$ = Pressure Differential = PSIG

$\Delta$ (from Greek Delta) is a change in something; in this case a change or drop in pressure at the valve as a result of system demand.
What is Pressure Drop?

- To determine Delta P across a valve, subtract the outlet pressure (P2) from the inlet pressure (P1).

The equation is \((P1) - (P2) = \Delta P\)
Ex: Pressure Drop

100psi - 95psi = Δ 5psi

Model 431 Valve: Flows 7.5 GPM @ 5psi differential (see table, next page)
## Pressure Drop Table

<table>
<thead>
<tr>
<th>Model #</th>
<th>Min Flow</th>
<th>Min Flow to ASSE 1017</th>
<th>Available Pressure at Valve</th>
<th>Flow Rate in GPM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>* Rate</td>
<td></td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>431</td>
<td>0.5</td>
<td>4</td>
<td>7.5</td>
<td>11</td>
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<tr>
<td>432</td>
<td>0.5</td>
<td>7</td>
<td>15</td>
<td>20</td>
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<tr>
<td>433</td>
<td>0.5</td>
<td>10</td>
<td>24</td>
<td>34</td>
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<tr>
<td>434</td>
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<td>15</td>
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<tr>
<td>1432</td>
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<td>14</td>
<td>18</td>
</tr>
<tr>
<td>1434</td>
<td>0.5</td>
<td>5</td>
<td>32</td>
<td>45</td>
</tr>
</tbody>
</table>

* Minimum flow when installed at or near hot water source with recirculating tempered water & continuously recirculating pump
Why is Pressure Drop Important?

- Pressure drop is a critical element in valve sizing and valve application. Pressure drop must be known by the engineer designing the system to ensure proper valve selection.
What Factors Determine Pressure Drop?

- Critical factors are orifice size and internal flow path.
- Ex: Full port-full open 1” ball valve with a Cv of 40 vs. a full open 1” diaphragm valve with a Cv of 15.
What is the Relationship between Flow Rate and Pressure Drop?

- Pressure drop and flow rate are dependant on one another. The higher the flow rate through a restriction, the greater the pressure drop. Conversely, the lower the flow rate, the lower the pressure drop.
What is Cv?

- The definition of Cv factor is the number of G.P.M. that will pass through a valve with a pressure drop of one (1) psi.

- A unit of measure for comparing valve flows.
How do $\Delta P$, $C_v$ and GPM work together to size a valve?

- Two of these elements are necessary to size a valve:

\[
GPM = C_v \sqrt{\frac{\Delta P}{G}} \quad C_v = \sqrt{\frac{GPM}{\Delta P}} \quad \Delta P = \left(\frac{GPM}{C_v}\right)^2 G
\]

Where $G$ = Specific Gravity of the Fluid
System Design

- Estimating Water Demand
- Pipe Sizing
- System Operating Pressure
- Master Mixing Valves
- Design Temperature
- Maintaining Temperature
Estimating Demand: Methods

- **Full Flow**
  - 50 units or less
  - Unusual demand

- **Hunter’s Method**
  - More than 50 units
  - Typical demand
Full Flow Sizing

• Used when there are less than 50 fixture units
• Add up requirement for all fixtures
• Multiply by H/C factor
• Determine Actual Flow Required (in gpm)

\[
\text{H/C Factor} = \frac{\text{Shower temp} - \text{cold temp}}{\text{Mixing Valve temp} - \text{cold temp}}
\]
Ex: Full Flow Sizing

- Outlet 105°F - CW 60 °F = 45 °F
- HW 125 °F – CW 60 °F = 65
  \[\frac{45}{65} = 69\%\]
- If the Fixture Requirement for 10 showers is 25 gpm, the valve should be sized at 69% of this requirement:
  \[69\% \times 25 = 17 \text{ gpm}\]
Full Flow Sizing

If the pressure available at the valve is **45 PSI**, we can select a valve that will Flow **17 GPM @ 25 PSI**. Our selection will be a 431.

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Hunter’s Curve

- Devised by Dr. Roy B. Hunter in the 1950s
- Concept of fixture unit weights with probability curves or “Hunter’s Curves”
- Modified since for today’s requirements
Hunters Curve

- Method for determining valve size based on hot water demand in plumbing systems.

- The probability function is used to determine the number of plumbing fixtures that would reasonably be expected to be in simultaneous operation.
Hunters Curve

- The demand for any given fixture in the system is the combination of:
  1. Cycle time
  2. Demand flow rate
  3. Frequency of Use
Hunters Curve

- The Hunter method is applicable to the design of all plumbing systems, it is especially useful for systems that expect a high public demand -- such as healthcare facilities, sports stadiums, schools, hotels, etc.
# Hunter’s Fixture Units by Facility Type

<table>
<thead>
<tr>
<th>Fixtures:</th>
<th>Apart. House</th>
<th>Club or Gym</th>
<th>Hospital</th>
<th>Hotel / Dormitory</th>
<th>Industrial Plant</th>
<th>School Office Bld</th>
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</thead>
<tbody>
<tr>
<td>Basins, Private Lavatory</td>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
</tr>
<tr>
<td>Basins, Public Lavatory</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Bathtubs / Showers</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>3.5</td>
<td>1.5</td>
</tr>
<tr>
<td>Dishwasher</td>
<td>1.5</td>
<td>-</td>
<td></td>
<td>Five (5) Fixture Units per 250 Seating Capacity</td>
<td></td>
<td></td>
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<tr>
<td>Therapeutic Bath</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Kitchen Sink</td>
<td>0.75</td>
<td>1.5</td>
<td>3</td>
<td>1.5</td>
<td>3</td>
<td>0.75</td>
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<tr>
<td>Pantry Sink</td>
<td>-</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
<td>-</td>
<td>2.5</td>
</tr>
<tr>
<td>Service Sink</td>
<td>1.5</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
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<tr>
<td>Circular Wash Fountain</td>
<td>-</td>
<td>2.5</td>
<td>2.5</td>
<td>-</td>
<td>4</td>
<td>2.5</td>
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<tr>
<td>Semicircular Wash Fount</td>
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In applications where the principal use is showers, as a gym, use conversion factor of 1.00 to obtain design water flow rate in gpm.

www.powerscontrols.com
Ex: Hunters Method Sizing
(Hotel w/100 Rooms)

100 Showers: \[ 100 \times 1.5 = 150 \text{ Fixture Units} \]
100 Private Lavs \[ 100 \times 0.75 = 75 \text{ Fixture Units} \]
10 Public Lavs: \[ 10 \times 1 = 10 \text{ Fixture Units} \]
2 Kitchen Sinks \[ 2 \times 1.5 = 3 \text{ Fixture Units} \]
5 Service Sink \[ 5 \times 2.5 = 10 \text{ Fixture Units} \]

TOTAL: 248 \text{ FIXTURE UNITS}
Hunter’s Method Sizing

Actual Flow Requirement at 248 Fixture Units = 50 gpm
Hunter’s Method Sizing

Most manufacturers have sizing programs available that make demand estimation with Hunter’s Curve a snap!
Estimating Available Pressure

- **Available Pressure**
  - Water Pressure At Valve
  - Minus 20 psi For the Last Fixture
  - Minus 5 psi for each floor the highest fixture is above the valve
  - Minus 2 psi for each 100’ of horizontal piping
Ex: Hunter’s Method Sizing

Pressure At the Inlet of the Valve: +60 psi
Min. Design Pressure @ Fixture: - 20 psi
2 Floors above Valve location: 5 psi x 2 - 10 psi
300’ of Horiz. Friction Loss: 300 x 0.02: - 6 psi
Total Available Pressure at the Valve: +24 psi

We now need a valve that will flow 50 gpm @ 24 psig
Select a valve with enough flow to meet your demand at the available pressure differential

### Select a Valve

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Our choice will be the 433 valve
Sizing Programs

Simple to use valve sizing programs will help you select the proper valve for any application by answering simple questions.
Sizing Programs

- Notes and Summary of Section.
- Save Projects
- Email/Share
Thank you.